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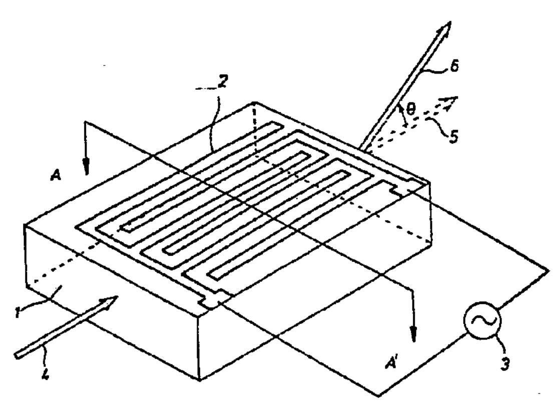
(54) **Electrooptic light deflector.**

(57) An electrooptic light deflector controls the deflection of a light beam in response to an applied electrical signal based on the electrooptic effect. In order to provide a comparatively large deflection angle (θ) without the necessity of a high-voltage generating circuit the deflector of the present invention comprises a plate (1) of a light transmissive material, electrodes (2) formed on the surface of the plate (1), and a voltage source (3) for generating a voltage, means for supplying the voltage to the plate (1) to change the distribution of the refractive index in its thickness direction so that a light beam (4) incident upon one end surface of the plate (1) is deflected in response to the change in the distribution of the refractive index formed in the plate (1).

FIG. 1



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ELECTROOPTIC LIGHT DEFLECTOR

This invention relates to an electrooptic light deflector for controlling the deflection of a light beam in response to an applied electrical signal based on the electrooptic effect.

To improve the signal processing speed of a data processing system or a communication system as well as to simplify the structure thereof, research and development efforts have been directed to printers and facsimile apparatuses based on photoelectric devices. To such a system, an electrooptic light deflector is indispensable for spatially and periodically controlling in response to an electric signal the deflection of a light beam supplied, for example, from a laser.

A conventional electrooptic deflector is proposed, for example, in U. S. Patent No. 3.887,885 (Reference 1), particularly in Fig. 2 thereof. The deflector shown in Reference 1 includes an

electrooptic crystal 10, interdigital electrodes (IDEs) 11 and 12 formed on the crystal surface and a circuit for applying an extremely low voltage having a high frequency, in response to a modulating signal applied to these IDEs. This deflector utilizes a diffraction phenomenon occurring in a layer, which is produced in the vicinity of the crystal surface. However, the deflection of the incident light beam depends on the refractive index of the layer which varies periodically in the direction of the thickness of the layer. As a result, the deflector cannot provide a large deflection angle.

In the above-mentioned system, there is also provided an optical modulator in which an extremely high voltage of about twenty kilovolts is applied to an electrooptic crystal, such as gadolinium molybdate so as to rotate the phase of the light beam for the modulation.

A typical optical light modulator is disclosed in an article by N.G. Theophanous, entitled "A $Gd_2(MoO_4)_3$ Longitudinal Electrooptic Modulator at 6328 Å", IEEE JOURNAL OF QUANTUM

ELECTRONICS, pp. 507-510, August issue, 1976 (Reference 2). This light modulator, however, requires a high-voltage generating circuit, resulting in a complicated and costly device.

It is, therefore, one object of the present invention to provide a simplified light deflector free from the above-described disadvantages and capable of providing a comparatively large deflection angle.

The present invention is based on the discovery that a certain kind of light transmissive crystal exhibits a nonlinear distribution of refractive index when electric field is applied in the thickness direction thereof and consequently that a light beam made incident onto the crystal in the direction perpendicular to the thickness direction is deflected in the thickness direction while travelling therethrough.

The deflector of the present invention comprises a plate of a light transmissive material, electrodes formed on the surface of the plate, and a voltage source for generating a voltage, means for supplying the voltage to the plate to change the distribution of the

refractive index in its thickness direction so that a light beam incident upon one end surface of the plate is deflected in response to the change in the distribution of the refractive index formed in the plate.

The invention will be described in detail in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective view of a first embodiment of the present invention;

Figs. 2A and 2B are diagrams for describing the principle of the present invention;

Figs. 3, 4, and 5 are graphs representing the relationship between a voltage applied, a light beam incident position, a modulating signal frequency, and a deflection angle, respectively;

Fig. 6 is a circuit diagram showing a part of the first embodiment;

Fig. 7 is a graph representing another deflection angle to

modulating signal voltage relationship in the first embodiment;

Figs. 8 and 10 are perspective views of second and third embodiments, respectively;

Figs. 9 and 11 are graphs representing the deflection angle - applied voltage relationships for the second and third embodiments;

Fig. 12 is a graph representing another deflection angle - applied voltage relationship for the third embodiment;

Fig. 13 is a perspective view of a fourth embodiment of the present invention;

Fig. 14 is a graph representing the deflection angle to applied voltage relationship in the fourth embodiment;

Fig. 15 is a graph representing another deflection angle to applied voltage relationship in the fourth embodiment; and

Figs. 16 and 17 are perspective views of fifth and sixth embodiments, respectively.

In the drawings, like reference numerals represent like structural elements.

Referring first to Fig. 1, the first embodiment of the present invention comprises a light transmissive body 1 made of a material having the trigonal crystal structure such as lithium niobate ($LiNbO_3$) or lithium tantalate ($TiTaO_3$), a plurality of interdigital electrodes (IDEs) 2 formed on the surface of the body 1 by a photolithographical method, and a voltage source 3 for supplying a high-frequency voltage to the IDEs 2. The IDEs are made of three layers of chromium (Cr), platinum (Pt), and gold (Au) respectively formed one after another on the body 1 in parallel to the direction of the incidence of light beam. For details of the lithographic method, reference is made to the description appearing in the column 6 of Reference 1.

A light beam 4 made incident onto one end surface of the body 1

is deflected upward, as denoted by an arrow 6 in Fig. 1, in response to a change in the refractive index developed in the body 1 in its thickness direction of the body 1 by the high-frequency voltage applied to the IDEs.

The principle of deflection of the light beam will be described with reference to Figs. 2A and 2B.

The application of the high-frequency voltage to be described later to the IDEs 2 raises the electric field intensity within the body not only at its surface but also at the various points lying in the thickness direction as shown in Fig. 2A. Due to the distribution of the field intensity, the refractive index exhibits a change from a large value at the upper portion of the body 1 to a small value toward the bottom portion thereof as shown in Fig. 2B. Consequently, the light beam incident upon the end surface of the body 1 is deflected upward by an angle of (+θ), in response to the refractive index distribution. If no voltage is applied to the IDEs 2, the light

beam 4 is emanated from the body 1 in the direction shown by an arrow 5 in Fig. 1 without being deflected.

Referring to Fig. 3, there is shown the relationship between a deflection angle and a voltage applied in the case where the body 1 consists of lithium niobate. The deflection angle was measured and shown in Table 2 (showing conditions of measurement for obtaining the deflection angle to applied voltage relationships corresponding to the materials for the light transmissive body) for various conditions and factors including voltage and frequency of the signal applied, types of electrodes, dimensions and materials of the body 1, the diameter of the incident light beam, and the incident position of the light beam in the body. Of those conditions shown in Table 2, condition 1 corresponds to the embodiment of Fig. 1.

Referring to Fig. 3, if the voltage applied is considerably low (i.e., lower than 15 V), a change in the refractive index takes place in the vicinity of the surface layer alone. Consequently, the incident light beam can hardly be deflected as is the case with the deflector disclosed in Reference 1. If the applied voltage is high (for example,

above a few hundred volts), then the line of electric force is distributed in parallel in the region between one surface and the other surface of the body 1. Accordingly, the refractive index of the body 1 does not undergo any change as in the modulator disclosed in Reference 2. The light beam is therefore not directed at all. It follows consequently that an optimum voltage for changing the distribution of the refractive index in the thickness direction of the body 1 must be applied. It will also be noted from Figs. 2A and 2B that the region of the body 1 in which the refractive index exhibits the change is limited to the vicinity of the region in which the IDEs 2 are formed. This indicates that an increase in the electrode length contributes to the increase in the deflection angle.

Referring to Fig. 4, the relationship between the incident position of a light beam (a distance from the top surface of the body) and the deflection angle is shown for the deflector of Fig. 1. The relationship is for the modulating signal of 40 megahertz (MHz) and

20 volts. It will be noted that the refractive index of the body 1 changes with the increase in distance from the surface of the body 1 as shown in Fig. 2A.

Fig. 5 shows a curve showing the deflection angle versus modulating signal frequency characteristics of the light deflector of Fig. 1, with the voltage fixed at 20 volts and with the light beam 4 made incident at a point 0.2 millimeters from the surface of the body. The curve indicates that the deflection angle is controllable not only by the voltage but also by the frequency of the modulating signal in the frequency range of up to 100 MHz.

Referring to Fig. 6, the high-frequency voltage generating circuit 3 used in Fig. 1 includes a transistor 3_1 for switching responsive to the sequence of input square pulses, an integration circuit 3_2 for integrating the output of the transistor 3_1, and a shaping circuit 3_3 for shaping the output of the integration circuit 3_2 into a saw-tooth wave. If the saw-tooth wave thus obtained is applied

to the IDEs 2 in Fig. 1. the light beam from the output side of the body is continuously deflected from the position 5 shown by a dotted line to the position 6 shown by a solid line, in response to a value of voltage of the saw-tooth wave. While the light transmissive body and electrodes are formed of the trigonal crystal and IDEs in the above-mentioned embodiment, the former may be formed of various other materials and the latter may be formed in various configurations, as will be described hereunder.

Fig. 7 shows a curve showing the deflection angle vs. applied voltage characteristics for the body 1 made of a polycrystal transparent ceramic (PLZT), with the light beam made incident onto the body 1 satisfying the conditions 2 shown in Table 2. With this structure, the light beam is deflected upward based on the principle of Figs. 2A and 2B.

Referring to Fig. 8, a second embodiment of the present invention has the body 1 made of bismuth germanium oxide ($Bi_{12}GeO_{20}$), one of

tetragonal crystals, and coplanar electrodes 70.

Fig. 9 shows a curve showing the deflection angle vs. applied voltage characteristics of the second embodiment for the body 1 made of $Bi_{12}GeO_{20}$ with the light beam made incident satisfying the conditions 3 given in Table 2.

Referring to Fig. 10, the third embodiment of the present invention includes the body 1 made of lead molybdate ($PbMoO_4$) having a tetragonal crystal structure. In a tetragonal crystal body, the change in the refractive index distribution due to the high-frequency voltage applied is reverse to that shown in Fig. 2A. More specifically, the refractive index in the vicinity of the surface of the body 1 is smaller than that in the vicinity of the bottom thereof. Consequently, the light beam 4 is deflected down by an angle of ($-\theta$) as represented as an output light beam 7 in Fig. 10.

Fig. 11 shows a curve for the third embodiment representing the deflection vs. applied voltage characteristics for the light beam

made incident onto the body 1 of $PbMoO_4$ satisfying the conditions 4 shown in Table 2.

When the light beam is made incident onto the body 1 under the conditions 5 shown in Table 2 with the body 1 made of an amorphous material such as glass (mainly including thirty-eight weight percent SiO_2 and sixty weight percent PbO), the deflection angle was $0.2°$. In the case, the light beam was deflected upward as in the case of Fig. 1. In addition to the above-mentioned embodiments, various modifications of the present deflector can be made using other materials shown in Table 1. More detailed description will be later about those modifications.

Table 1

Optical Material Used			Direction of Deflection
Polycrystal		$(Pb, La)(Zr, Ti)O_3$ or $(Pb, Bi)(Zr, Ti)O_3$	$+\theta$
Amorphous Material		glass (SiO_2 38%, PbO 60%), TeO_2 glass, or As_2S_3 glass	$+\theta$
Crystal	Triclinic Crystal	$CsH_3(SeO_3)$	$+\theta$
	Trigonal Crystal	$LiNbO_3$ or $LiTaO_3$	$+\theta$
	Monoclinic Crystal	$C(CH_2OH)_4$ or $Ca_2Nb_2O_7$	$+\theta$
	Hexagonal Crystal	TeO_2, $YAlO_3$ or SiO_2	$+\theta$
	Rhombic Crystal	α-HIO_3, $Ba_2NaNb_5O_{15}$, or Rochelle salt	$+\theta$
	Cubic Crystal	$Y_3Al_5O_{12}$, $Gd_3Ga_5O_{12}$, $Bi_{12}GeO_{20}$, GaAs, ZnS, or Gap	$+\theta$
	Tetragonal Crystal	$PbMoO_4$, TiO_2, $CaWO_4$, $BaTiO_3$, KH_2PO_4, or $NH_4H_2PO_4$	$-\theta$

In the tetragonal crystal group shown in Table 1, rutile (TiO_2) having a small lattice spacing gives the refractive index change similar to the one in $PbMoO_4$ even when a direct current voltage is applied. By the use of such a crustal, a light deflector free from the above-mentioned circuit 3 can be provided.

Fig. 12 shows another deflection angle vs. applied voltage characteristics for the light beam made incident onto the body made of rutile satisfying the conditions 6 shown in Table 2.

Referring to Fig. 13, the fourth embodiment of the present invention adapted to provide a larger deflection angle comprises a light transmissive body 8 made of lithium niobate and having a light-beam output side surface tapered toward the bottom thereof, interdigital electrodes (IDEs) 2 formed on the surface of the body 8 by a photo-lithographical method, and a circuit 3 for applying a high-frequency voltage to the IDEs 2. Unless the high-frequency voltage is applied to the body 8, the light beam 4 incident onto the body 8 is emanated

in the direction as represented by an arrow 9. In the presence of high-frequency voltage applied to the body 8, the incident light beam 4 is deflected upward in the direction as represented by an arrow 10 due to the change in the refractive index distribution.

Fig. 14 is a graph representing the relationship between the deflection angle α of a light beam incident onto the body made of $LiNbO_3$ and the deflection angle β of output light beam. Each deflection angle is obtained by calculation according to the Snell's law for the case where the side surface of the body 8 of Fig. 13 is tapered at 65°, and the light beam is given into the body under the conditions 7 given in Table 2. Therefore, it is observed that the deflection angle is greatly increased as compared to that of Fig. 1.

Fig. 15 shows the relationship between the deflection angle α and the deflection angle β for the case where tapering angle γ of the body 8 (Fig. 13) is set at 110°. As a result, it is inferred that the deflection angle β changes substantially linearly relative to the

deflection angle α of the incident light. Since the deflection angle α is controlled in the embodiment of Fig. 13 by the high-frequency voltage applied, the incident light beam is continuously deflected in response to the saw-tooth wave voltage applied to the IDEs from the voltage source (Fig. 6).

Referring to Fig. 16, the fifth embodiment adapted to provide a larger deflection angle comprises a light transmissive body 11 made of lithium niobate and having silver reflection films 16 and 17 formed on a part of the light-beam incident surface and light-beam output surface thereof, respectively, a high-frequency voltage source 3, and IDEs 2 formed on the top surface of the body 11 so as to change the refractive index of the body 11 in response to the high-frequency voltage fed from the source 3. With this structure, it is assumed now that the light beam 4 is made incident onto the non-reflection-film portion of the surface of the body 11. In the absence of the high-frequency voltage applied to the IDEs 2, the incident light

beam 4 is reflected by the reflection film 17 and then by the reflection film 16, and emanates as a light beam 12 from the output surface of the body 11. With the high-frequency voltage applied to the IDEs 2, the incident light beam 4 is deflected due to the refractive index change and then reflected by the reflection film 17. The light beam thus reflected is again deflected in the body 11, then reflected on the reflection film 16, again deflected by the body 11, and eventually emanates therefrom in the direction shown by an arrow 13. This embodiment is equivalent to the case where the body 11 is lengthened, providing a larger deflection angle. In this embodiment, when the light beam is made incident onto the body 11 satisfying the conditions 8 shown in Table 2, the incident light beam is deflected by 6 degrees.

Referring to Fig. 17, the sixth embodiment of the present invention comprises a rectangular parallelepiped light transmissive body 14 made of lithium niobate; interdigital electrodes (IDEs) 2A and 2B formed on the top and bottom surfaces of the body 14 and

arranged to cause deflection of the incident light beam in the vertical direction (in w and x directions as represented by arrows); interdigital electrodes IDEs 2C and 2D formed on the opposite left and right side surfaces of the substrate 14 and arranged to cause deflection of the incident light beam in the horizontal direction (in y and z directions as represented by arrows); and high-frequency voltage source 3A to 3D for applying high-frequency voltages to these IDEs 2A through 2D, respectively. According to this structure, the light beam 4 is deflected in a desired direction, in response to the high-frequency voltages applied to the IDEs 2A to 2D from the sources 3A through 3D.

While preferred embodiments of the invention have been described, many modifications can be made by those skilled in the art within the scope of the claimed invention.

TABLE 2

CONDITIONS			1	2	3	4	5	6	7	8
Embodiment			1	1	2	3	3	4	5	6
Structure			Fig. 1	Fig. 1	Fig. 8	Fig.10	Fig. 1	Fig. 8	Fig.13	Fig.16
Characteristic			Fig. 3	Fig. 7	Fig. 9	Fig.11		Fig.12	Fig.14	
Material of Substrate			$LiNbO_3$	PLZT	$Bi_{12}GeO_{20}$	$PbMoO_4$	glass: SiO_2 38% PbO 60%	TiO_2	$LiNbO_3$	$PbMoO_4$
Deflection Angle (degree)			1.7	4.1	0.65	2.4	0.2	0.6	4	6
Applied Voltage (Volt)			28	14	18	20	20	40	28	20
Drive-Frequency (MHz)			40	109	185	240	180	0 (direct)	40	240
Dimension of Substrate, in mm (length x width x thickness)			14x12x2	10x10x2	16x16x0.5	11x11x2	13x13x1	10x10x1	14x12x2	11x11x2
Diameter of Light Beam (μm)			200	200	200	200	200		200	200
Incident Position of Beam (mm) Distance from Surface			0.2	0.2	0.2	0.2	0.2		0.2	0.2
Kinds of Electrodes	Interdigital Electrodes	Number of Pair	20	16		16	16		20	16
		Gap of Electrode (μm)	15	16		16	16		15	16
		Width of Electrode (μm)	15	16		16	16		15	16
		Thickness of Electrode (Å)	1000	1000		1000	1000		1000	1000
		Length of Overlapped Electrode, (mm)	10	8		8	10		10	10
	Coplanar Electrodes	Length of Electrode (mm)			15			10		
		Width of Electrode (mm)			0.3			0.2		
		Gap of Electrode (μm)			25			10		
		Thickness of Electrode (Å)			1000			1000		

C l a i m s

1. An electrooptic light deflector comprising:
   a) a light transmissive body (1, 8, 11) changing the refractive index when subjected to an electric field;
   b) a plurality of electrodes (2) arranged on the surface of said body (1, 8, 11);
   c) a voltage source (3) for generating a voltage and
   d) means for applying said voltage to said electrodes so that said change in the refractive index may be caused in the area defined by said electrodes (2) and in the direction of thickness of said body (1, 8, 11);

   whereby a light beam (4) incident onto one end surface of said body is deflected in response to said voltage.

2. An electrooptic light deflector as claimed in Claim 1, wherein said body is made of triclinic crystal made of $CsH_3(SeO_3)$.

3. An electrooptic light deflector as claimed in Claim 1, wherein said body is made of a trigonal crystal of a material chosen from the group consisting of $LiNbO_3$ and $LiTaO_3$.

4. An electrooptic light deflector as claimed in Claim 1, wherein said body is made of a monoclinic crystal of a material chosen from the group consisting of $C(CH_2OH)_4$ and $Ca_2Nb_2O_7$.

5. An electrooptic light deflector as claimed in Claim 1, wherein said body is made of a hexagonal crystal of a material chosen from the group consisting of TeO_2, $YA\ell\ O_3$ and SiO_2.

6. An electrooptic light deflector as claimed in Claim 1, wherein said body is made of a rhombic crystal of a material chosen from the group consisting of α-HIO_3, $Ba_2NaNb_5O_{15}$, and Rochelle salt.

7. An electrooptic light deflector as claimed in Claim 1, wherein said body is made of a cubic crystal of a material chosen from the group consisting of $Y_3A\ell_5O_{12}$, $Gd_3Ga_5O_{12}$, $Bi_{12}GeO_{20}$,

GaAs. ZnS, and GaP.

8. An electrooptic light deflector as claimed in Claim 1, wherein said body is made of a tetragonal crystal of a material chosen from the group consisting of $PbMoO_4$, TiO_2, $CaWO_4$, $BaTiO_3$, KH_2PO_4, and $NH_4H_2PO_4$.

9. An electrooptic light deflector as claimed in Claim 1, wherein said body is made of a polycrystal of a material chosen from the group consisting of (Pb, La) (Zr, Ti)O_3 and (Pb, Bi) (Zr, Ti)O_3.

10. An electrooptic light deflector as claimed in Claim 1, wherein said body is in amorphous state of a material chosen from the group consisting of glass of (SiO_2, PbO), glass of TeO_2, and glass of As_2S_3.

11. An electrooptic light deflector as claimed in any of claims 1 to 10, wherein said electrodes (2) are interdigital electrodes (IDE).

12. An electrooptic light deflector as claimed in any of claims 1 to 11, wherein said electrodes (2) are coplanar electrodes.

13. An electrooptic light deflector as claimed in any of claims 1 to 12, wherein said body (8) has a light-beam output surface tapered toward one surface thereof.

14. An electrooptic light deflector as claimed in any of claims 1 to 13, wherein a reflection film (16, 17) is formed on one of light-beam incident surface and light-beam output surface of said body (11), respectively.

15. An electrooptic light deflector as claimed in any of claims 1 to 14, wherein said voltage source (3) is a saw-tooth wave generating circuit.

16. An electrooptic light deflector as claimed in any of claims 1 to 15, wherein said voltage source (3) is a high frequency voltage generating circuit.

17. An electrooptic light deflector comprising:

a) a parallelepiped light transmissive body (14) changing the refractive index when subjected to an electric field;

b) first through fourth electrode arrangements (2A to 2D) arranged on first through fourth side surfaces of said body (14) except for the light-beam incident surface and the light-beam output surface thereof, each having a plurality of interdigital electrodes;

c) first through fourth voltage sources (3A to 3D) for generating voltages;

d) means for applying said voltages to said electrodes (2A to 2D) so that said change in the refractive

index may be caused in the area defined by said electrodes (2A to 2D) and in the direction of thickness of said body (14);

whereby a light beam (4) incident onto one end surface of said body (14) is deflected in response to said voltage.

FIG. 1

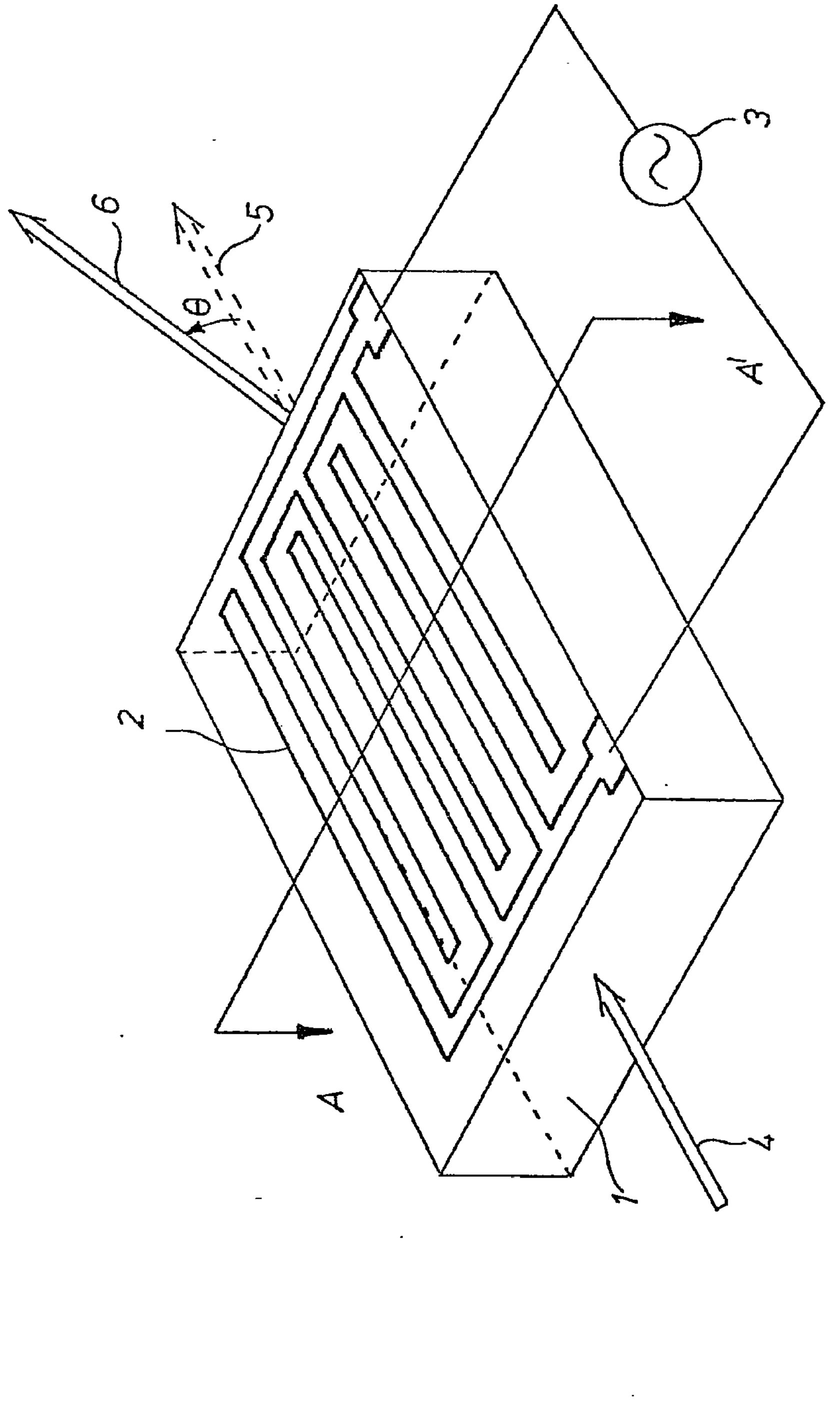
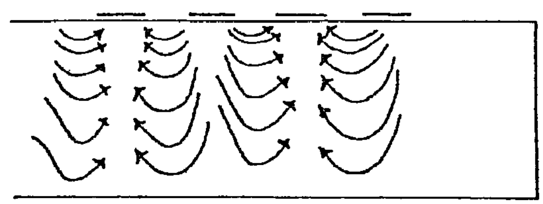


FIG. 2a



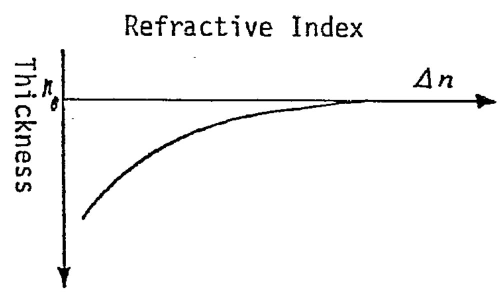


FIG. 2b

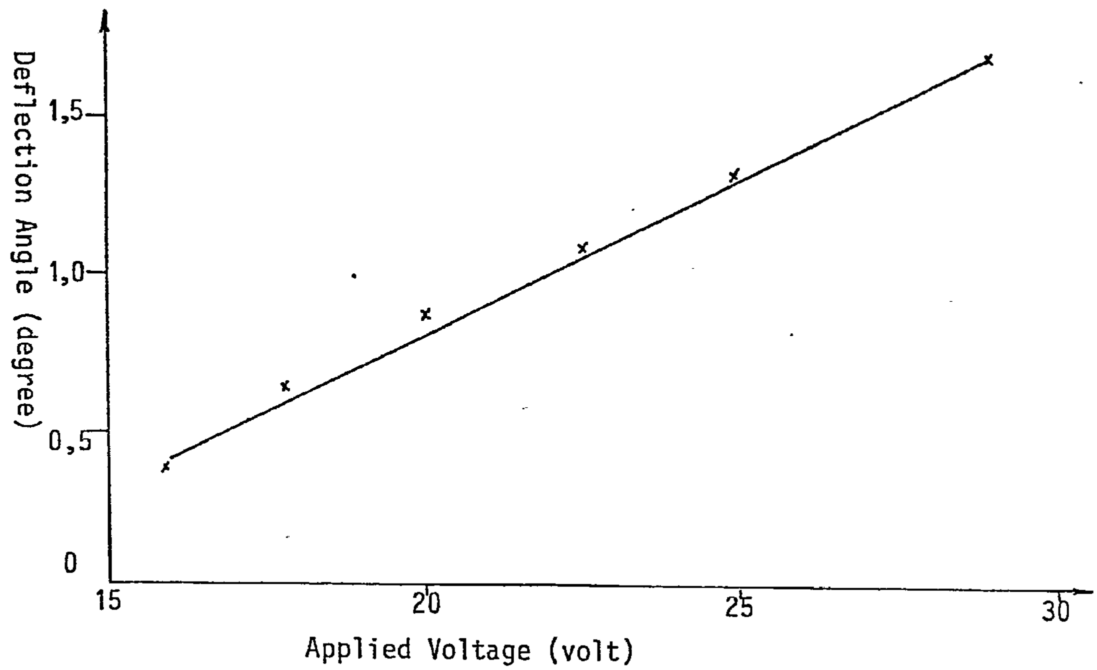

Deflection Angle (degree)
1,5
1,0
0,5
0
15
20
25
30
Applied Voltage (volt)

FIG. 3

FIG. 4

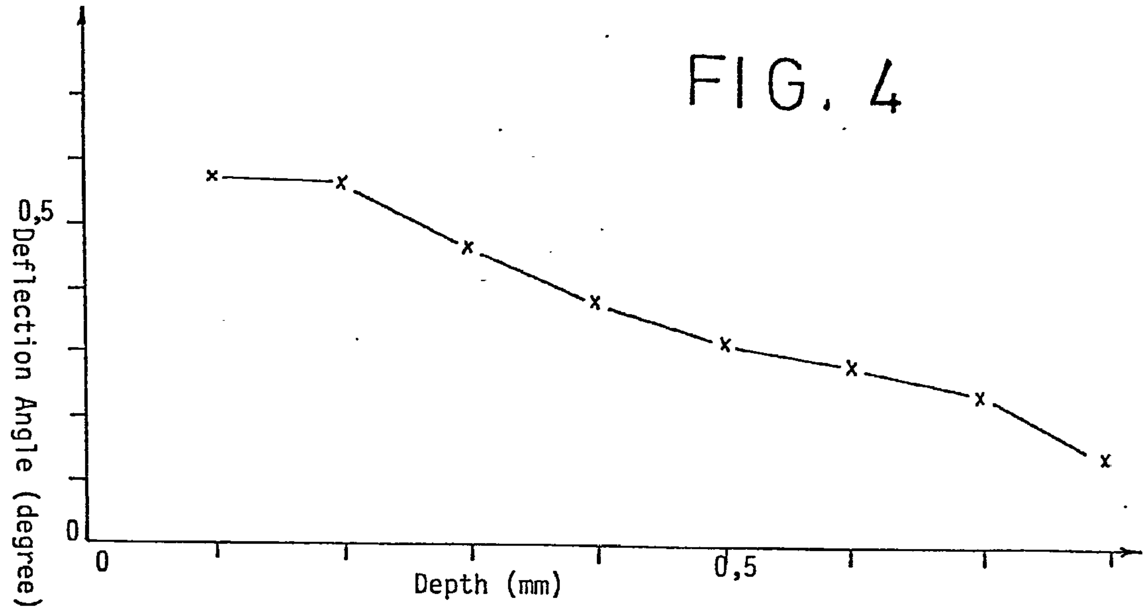

0,5
0
Deflection Angle (degree)
0
0,5
Depth (mm)

FIG. 5

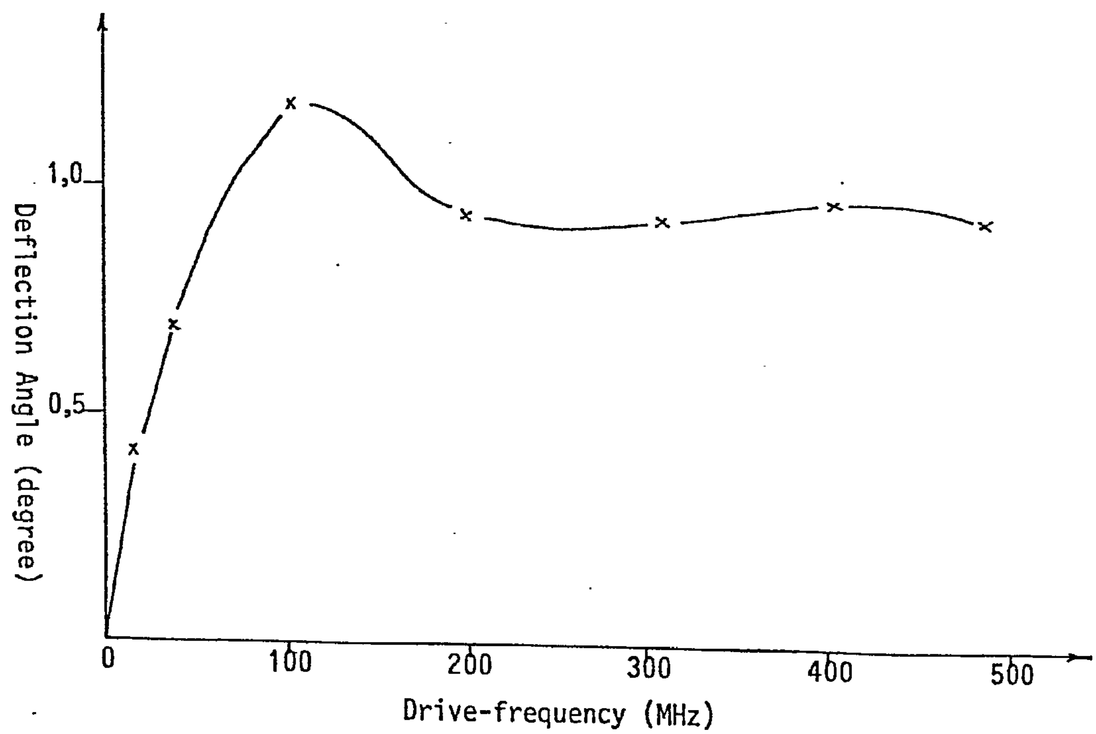

1,0
0,5
Deflection Angle (degree)
0
100
200
300
400
500
Drive-frequency (MHz)

FIG. 6

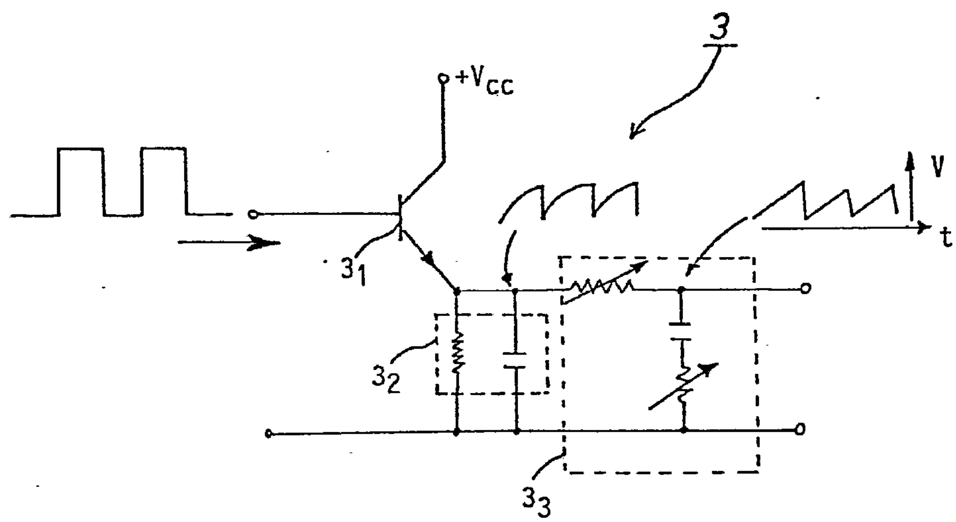
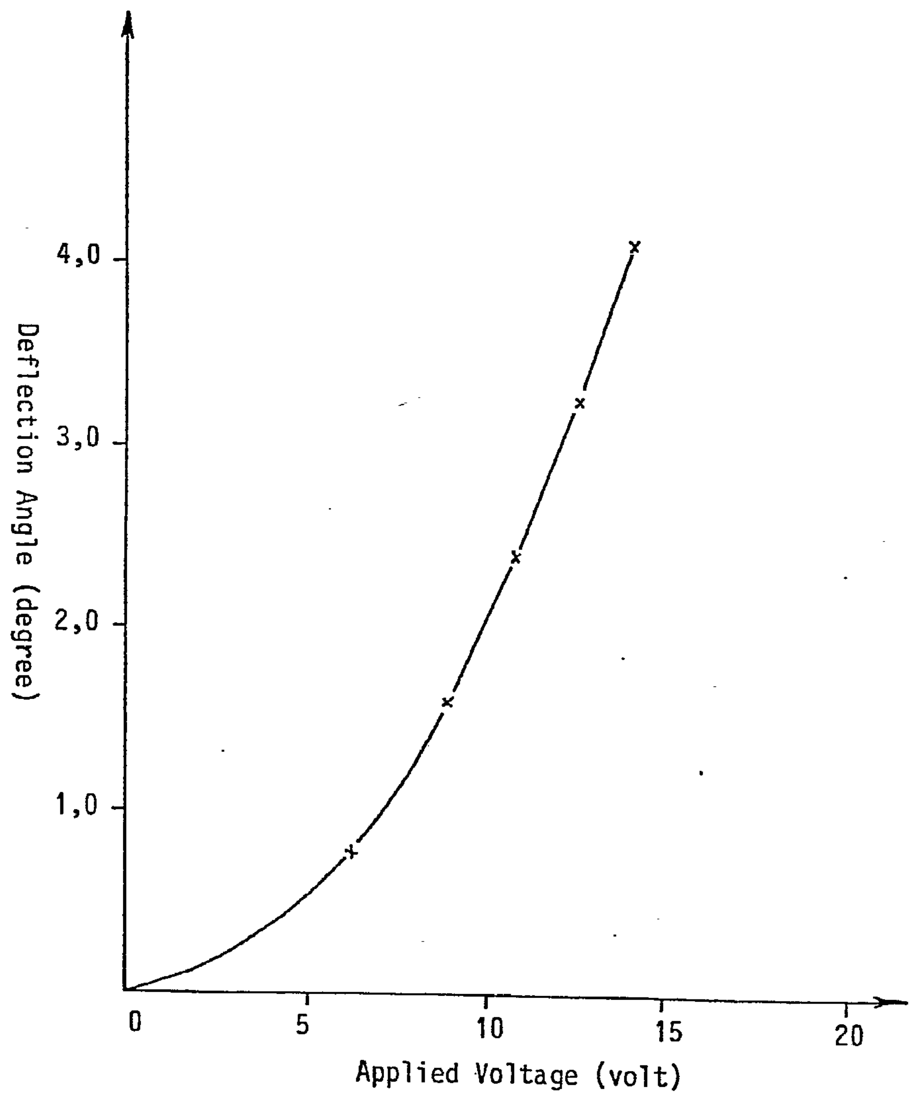


FIG. 7


4,0
3,0
2,0
1,0
Deflection Angle (degree)
0
5
10
15
20
Applied Voltage (volt)

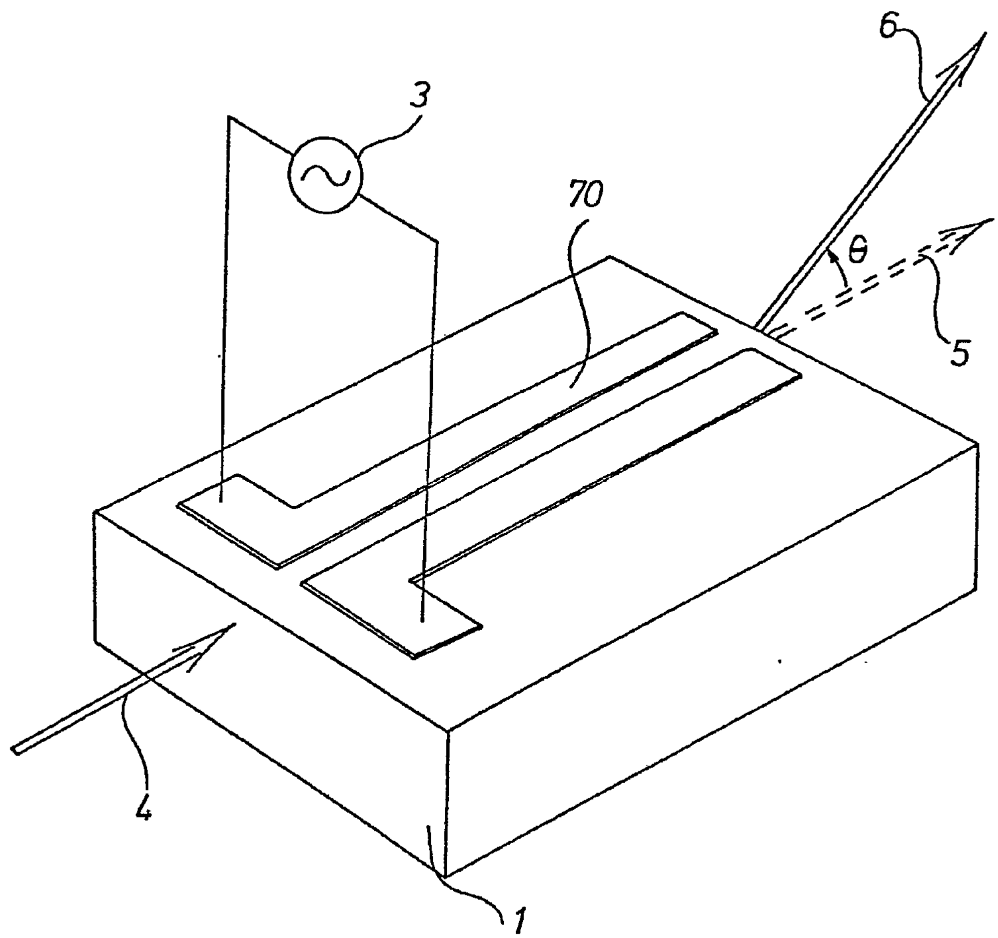


FIG. 8

FIG. 9

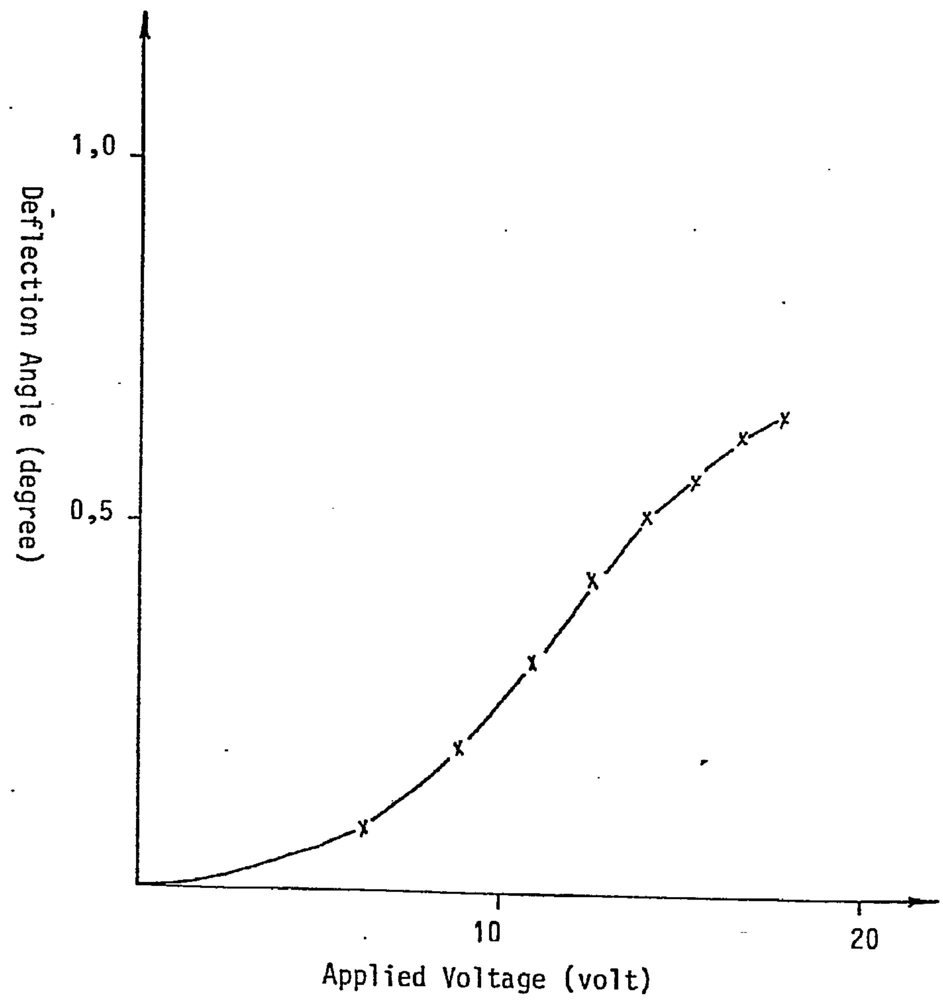


FIG. 10

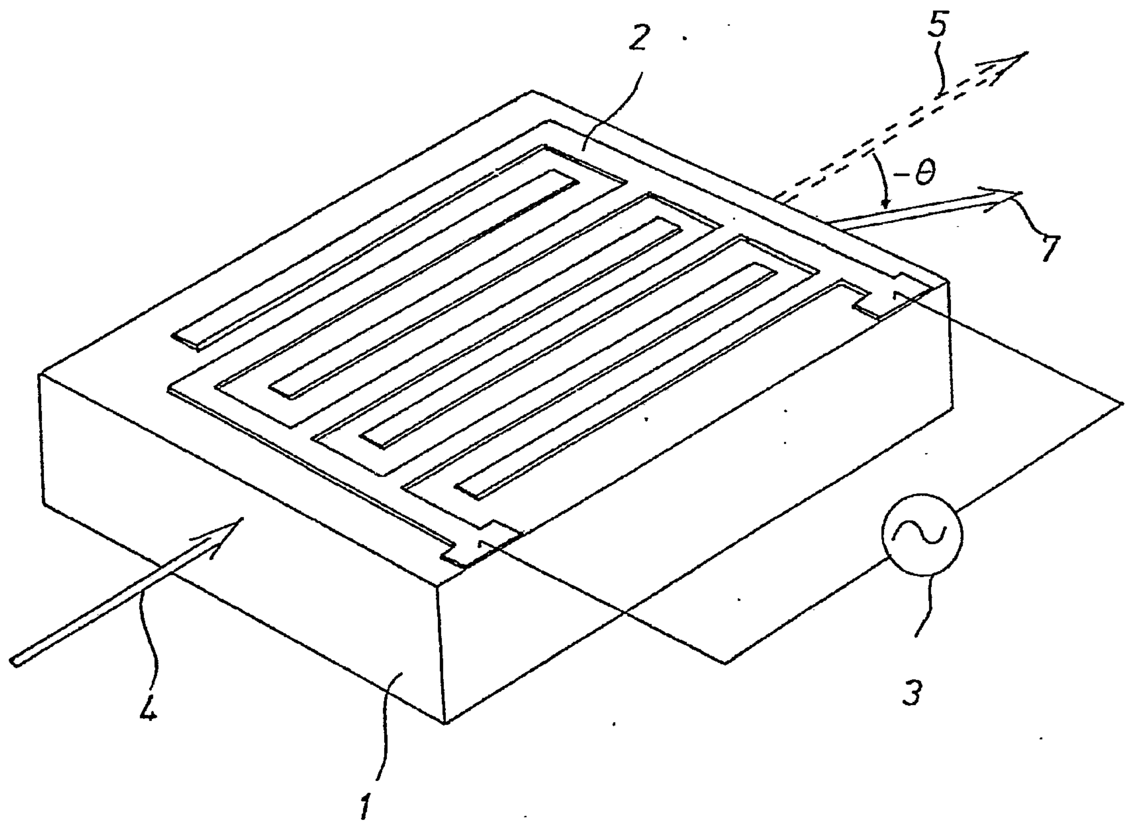


FIG. 11

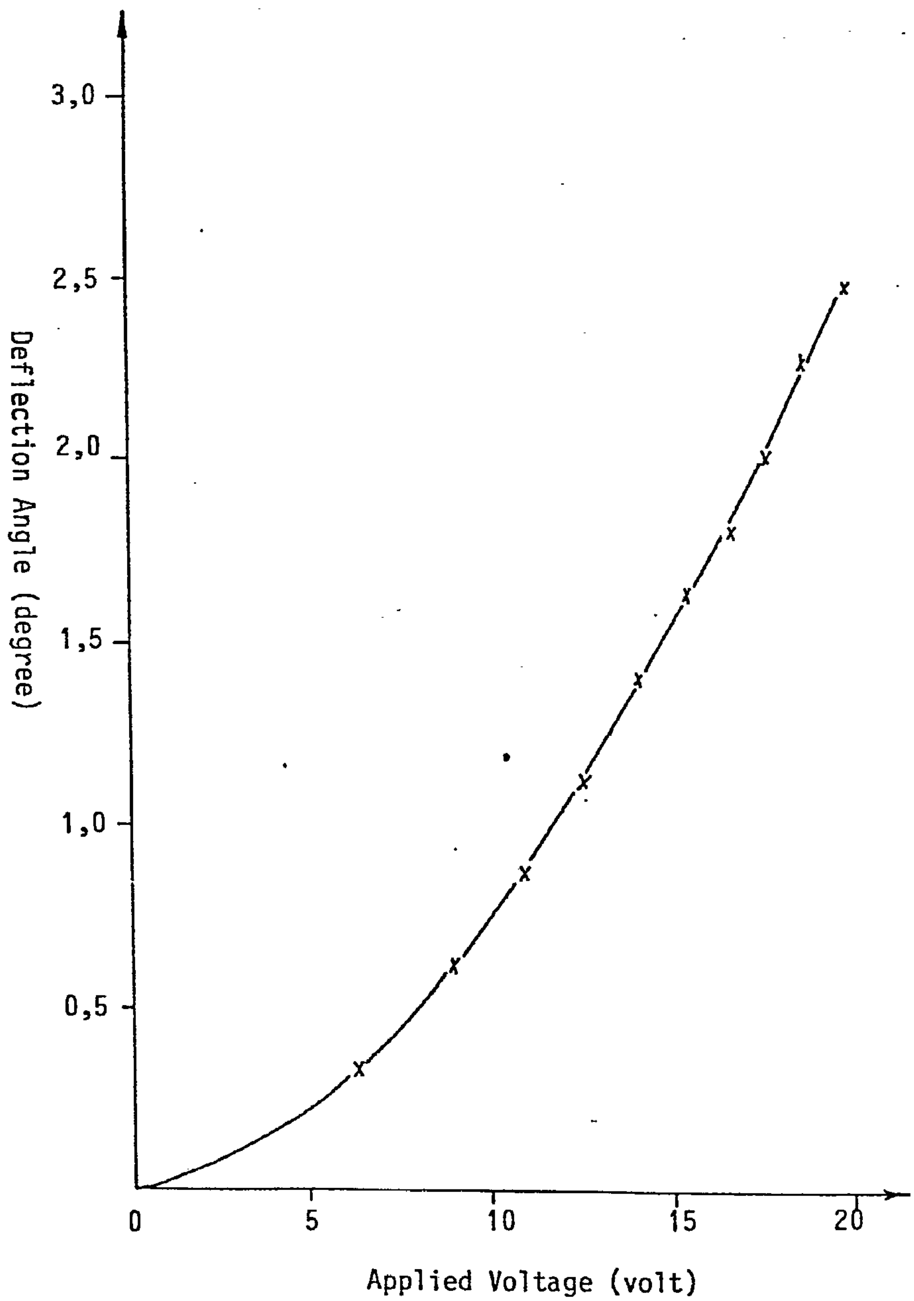

3,0
2,5
2,0
1,5
1,0
0,5
Deflection Angle (degree)
0
5
10
15
20
Applied Voltage (volt)

FIG. 12

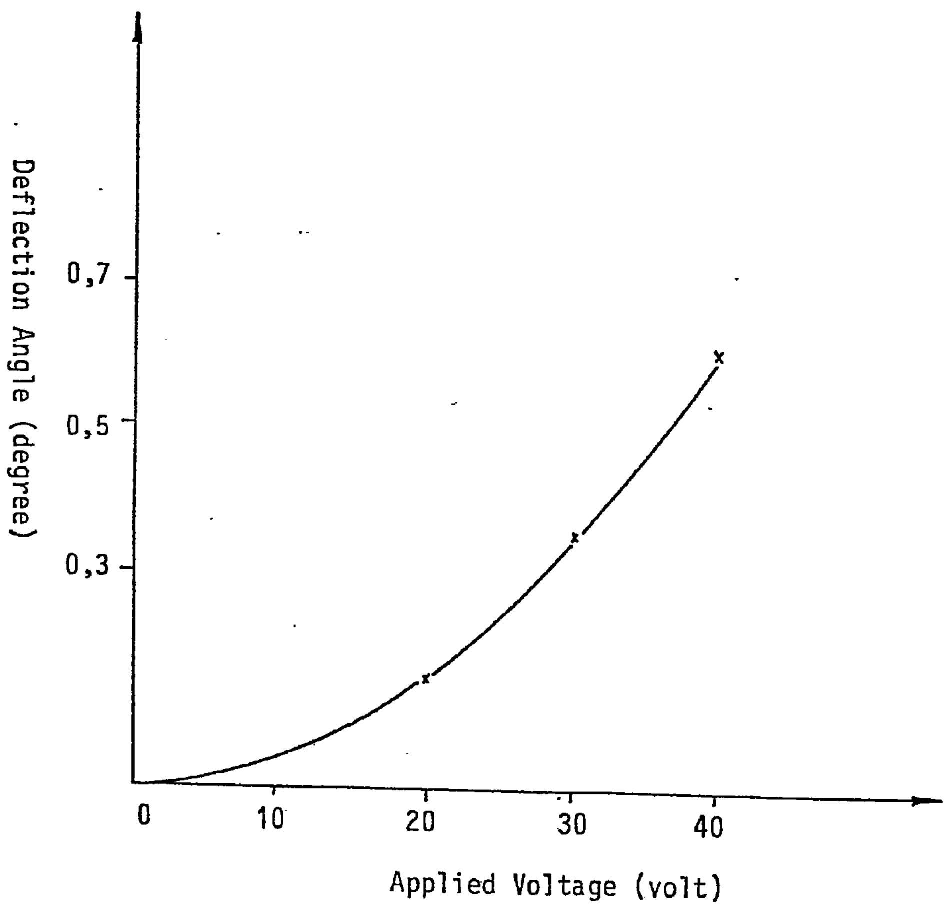

Deflection Angle (degree)
0,7
0,5
0,3
0
10
20
30
40
Applied Voltage (volt)

FIG. 13

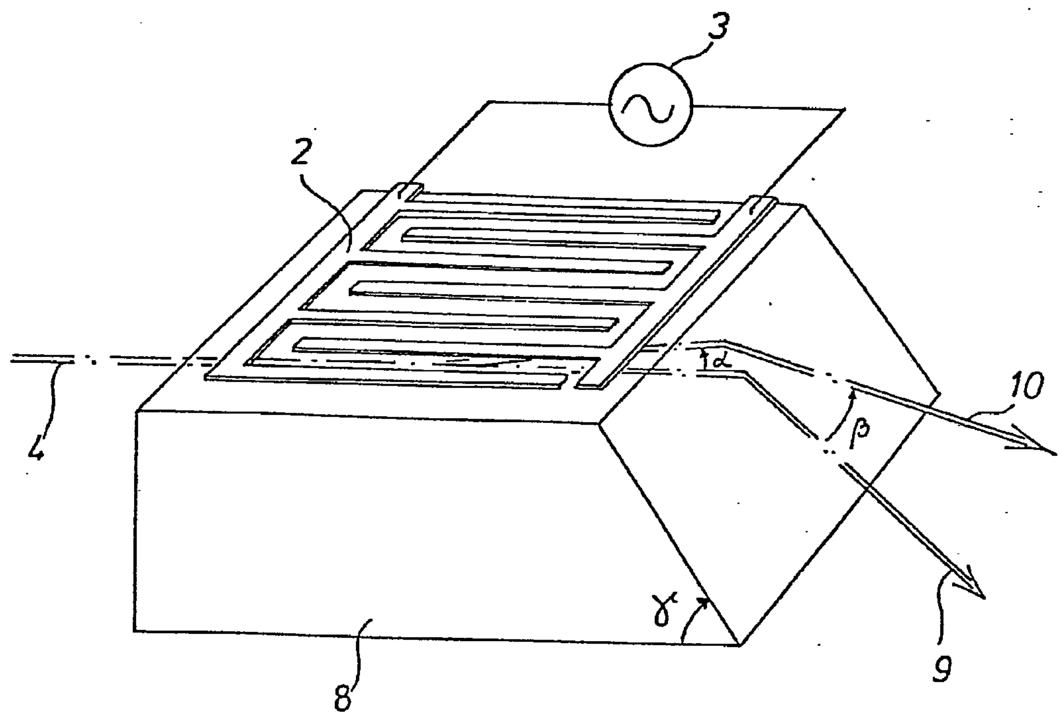


FIG.14

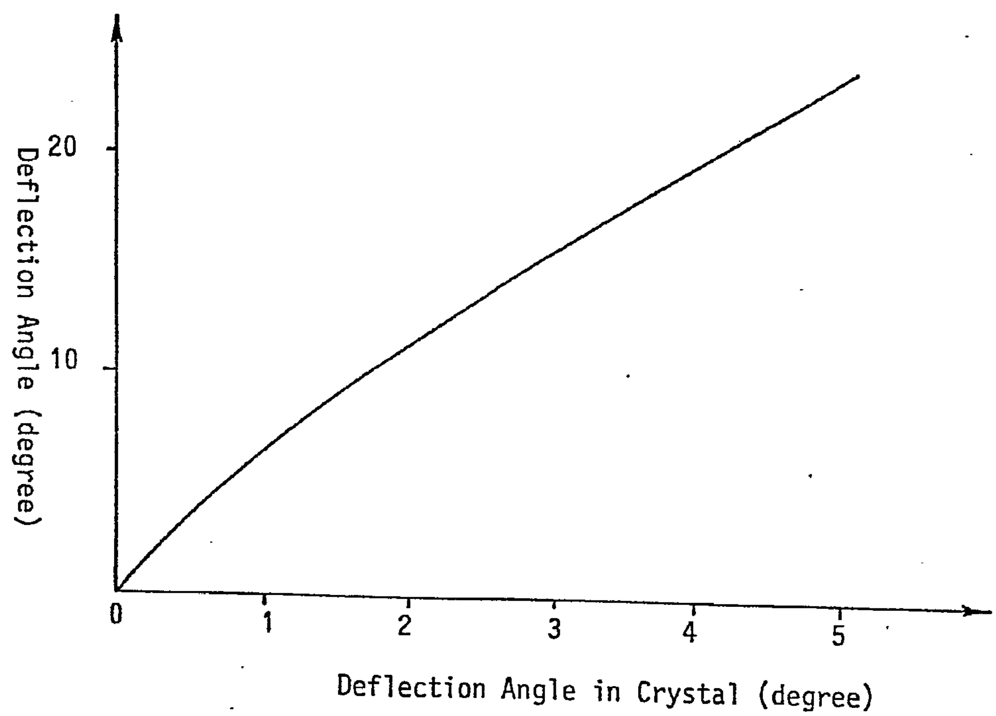
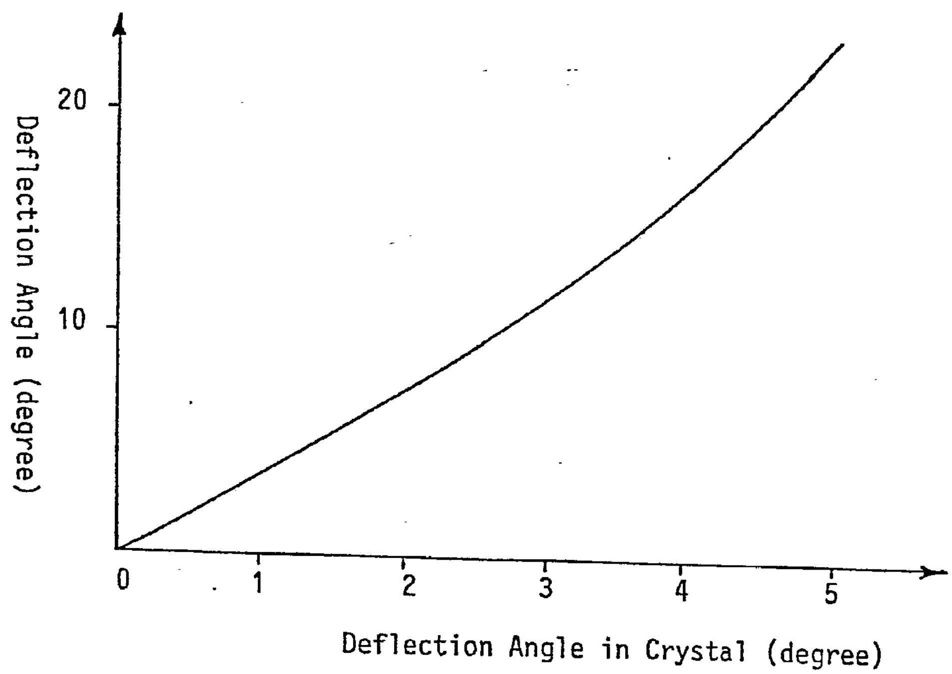

20
10
Deflection Angle (degree)
0
1
2
3
4
5
Deflection Angle in Crystal (degree)

FIG. 15


20
10
Deflection Angle (degree)
0
1
2
3
4
5
Deflection Angle in Crystal (degree)

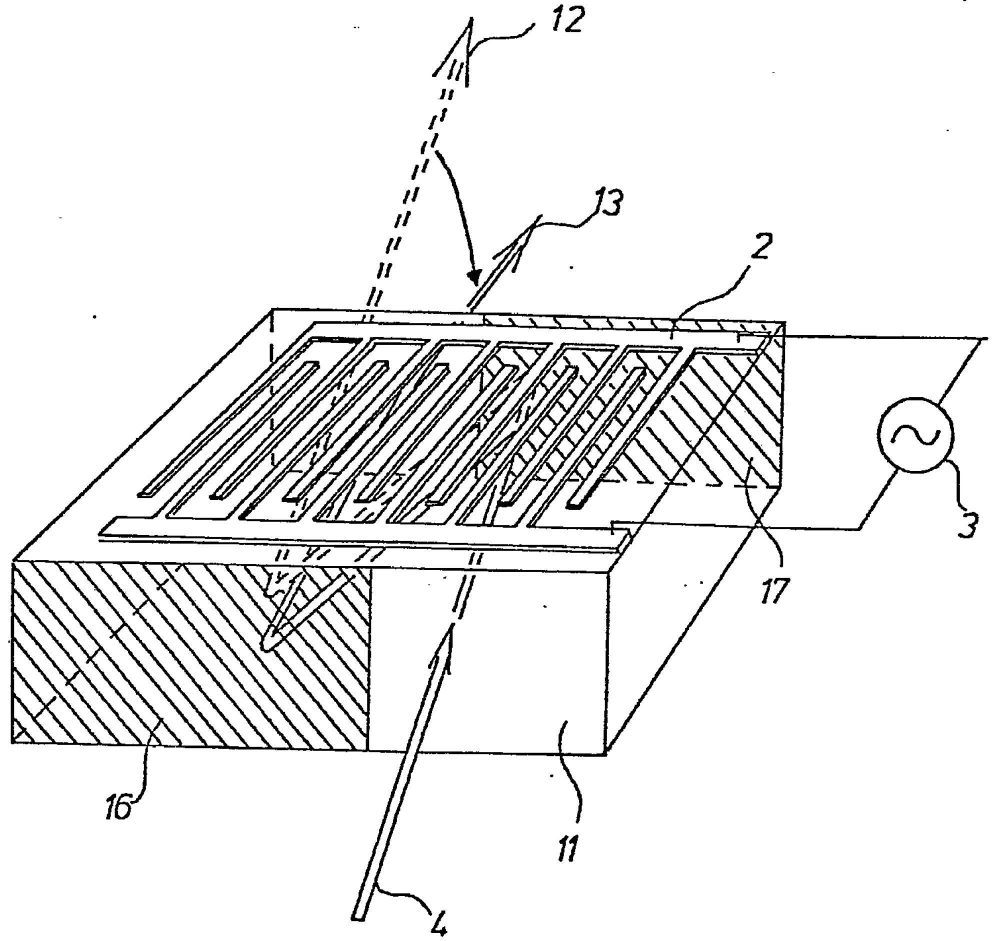
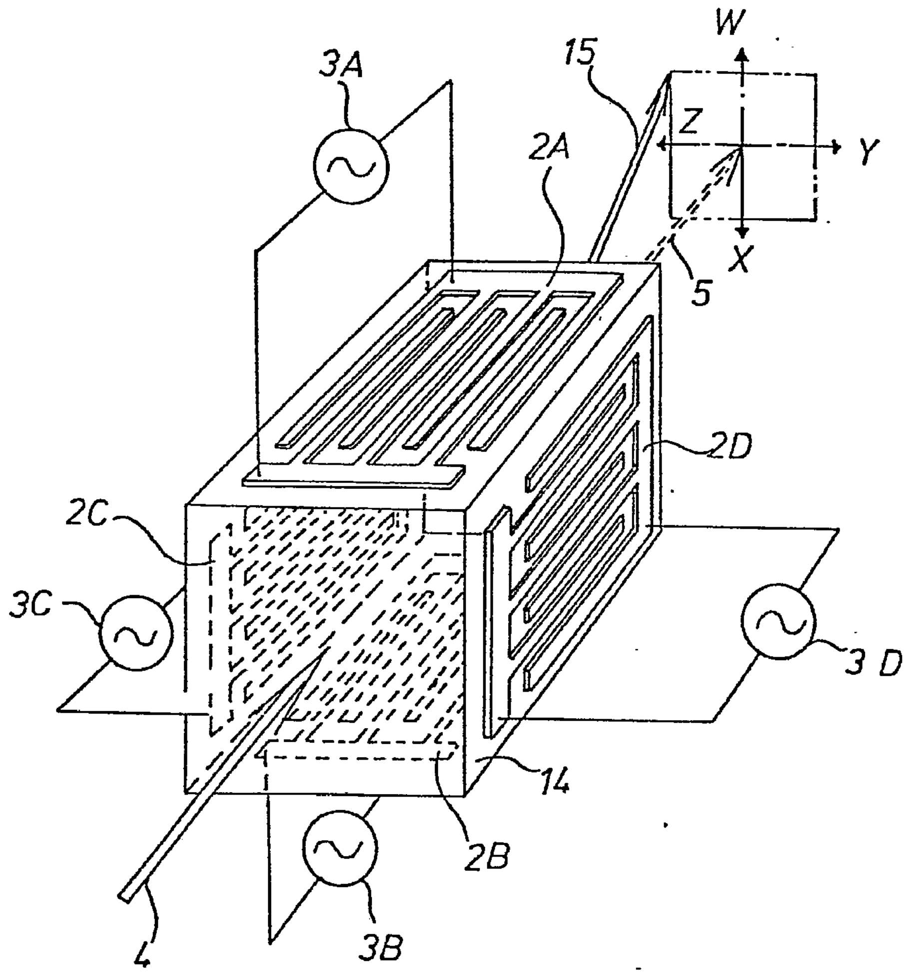


FIG. 16

FIG. 17



0019278

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EUROPEAN SEARCH REPORT

Application number

EP 80102691.5

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	DE - B2 - 2 164 712 (HEWLETT-PACKARD) * Fig.3; column 4, line 1; column 2, lines 67,68 * --	1,3,11, 12,13, 16	G 02 F 1/29
A	CH - A5 - 591 097 (INT.STANDARD ELECTRIC) * Column 1, lines 4 to 8; figures 1,3; column 2,line 22* --	1,11,12, 15	
A	DE - B1 - 1 303 849 (IBM) * Column 4, line 11 * --	8	TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
A	DE - A1 - 1 764 944 (US ATOMIC ENERGY COMMISSION) * Page 6, lines 19,20 * --	6	G 01 D G 01 R 13/00 G 02 F G 06 F 7/00 G 11 B 7/00 G 11 C 13/00 H 01 S 3/00 H 03 K 17/00 H 04 N 1/00 H 04 N 3/00
X	DE - A1 - 2 057 183 (NIPPON TELEGRAPH) * Page 4, lines 1 to 3,11,24; page 5, lines 18,19; lines 28 to page 6, line 2 * --	1,3,7, 8,16	
A	DE - A1 - 2 436 702 (HITACHI) * Claim 3; tab.1,pages 4 to 7; page 21, line 13; page 20, last line * --	5,6,8	CATEGORY OF CITED DOCUMENTS
X	US - A - 4 066 338 (HAGIWARA DENKI KABUSIKI) * Abstract; Fig.8,9; column 2, line 30 * --	1,11,12 13,16	X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
A	US - A - 4 004 847 (Mc NANEY) * Fig. 3; column 1, lines 47 to 51 * --	11,12	
X	The present search report has been drawn up for all claims		&: member of the same patent family, corresponding document

Place of search	Date of completion of the search	Examiner
VIENNA	28-07-1980	KUNZE

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Application number

European Patent Office

EUROPEAN SEARCH REPORT

EP 80 10 2691

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
	DE - B - 1 244 961 (IBM) * Column 2, lines 50-52; column 3, line 40; column 4, line 18; figure 1 * --	1,8, 13,14	
X	DE - A - 1 805 395 (HONEYWELL) * Page 4, lines 3-5, line 26; figure 6 * --	1,8, 14	
A	DE - A - 2 624 916 (WESTERN ELECTRIC) * Claim 3 * --	1,3,12	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
A	US - A - 3 736 046 (HONEYWELL) * Figure 3; column 3, lines 45 to 50; column 4, lines 27-31 * --	1,7,17	
X	US - A - 3 887 885 (HAGIWARA DENKI) * Figures 2,4; column 1, lines 22-25; column 2, lines 31-35; column 8, lines 8,9 * ----	1,3,11, 12,16	

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